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ABSTRACT

The innovative educational techniques of discovery and inquiry learning and their relevance to the education of academically gifted children are discussed. Following discussion of various definitions of discovery and inquiry, the two terms are dealt with synonomously to avoid confusion. Brief historical background information is given on the growth of discovery and inquiry as educational techniques. Examined are the relationship of these teaching approaches to theory and also the rationale for implementing such techniques in the education of the gifted. Application of the methods in the classroom is considered in terms of the characteristics which must be present in the classroom and learning environment, tools and materials which facilitate the approach, and teacher functions. Recent research concerning the two teaching methods is reviewed and listed are some current programs that specifically use the discovery-inquiry approach in their methodology. (KW)

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DISCOVERY AND INQUIRY
THEIR RELEVANCE AS
APPROACHES FOR TEACHING
THE GIFTED

By

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Acknowledgement:

The purpose of this paper was to consider the innovative educational techniques of discovery and inquiry and their relevance to the teaching of academically gifted children. With the emphasis on individualizing instruction, the authors feel that a knowledge of these techniques might help the teacher to help the student actualize herself/himself to reach her/his full potential as a student and a citizen.

"The art of being taught is the art of discovery, as the art of teaching is the art of assisting discovery."
Mark Van Doren

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CHAPTER I

INTRODUCTION

Along with the new terminology resulting from the technological complexities of Sputnik in 1957, came a new set of curriculum plans that were to bridge the gap in our realm of content and knowledge. After the content areas were saturated with innovative "packaged programs" of what to teach, educators became increasingly concerned with how to teach these same programs. Hence, the stress became one of process. Among the new terms arising from the emphasis on innovative educational methods and techniques were discovery and inquiry.

The purpose of this paper was to consider these two techniques and their relevance as approaches for teaching gifted children. Although these approaches have been and may be applied to many different intellectual and ability levels, this paper will be directed solely to the effect of these techniques on academically gifted youth.

It now becomes imperative to define these terms: What is discovery? What is inquiry? How are they similar? How do they differ?

There are several distinct definitions for both terms: first, the writer will examine the term discovery. Ohles described this method in terms of the child thusly:

> The youngster brings techniques of learning to the school. As an infant, he learned to handle, feel, bite, drop, throw, pile this on that, or place one object inside another. Through manipulation he found relationships, characteristics, potentials, and limitations. He learned that one may try and lay aside, try from another angle and once more quit, and then return again to eventually solve a problem. Experience has provided him with opportunities to learn that one may solve a problem on one's own or take a problem to someone else who will solve the problem or show how it may be done. He has found that adults may direct learning and be quite insistent and forceful in what, when, and how a youngster

> shall learn. He has probably experienced situations in which something to be learned has been stubbornly elusive and then has suddenly become obvious. This is related to what educators call the discovery method of learning.[1]

Ter Keurst and Martin defined this process as: "The act of discovery is the result of problem solving and is an illustration of creative activity. It is a personal experience to the learner, accomplished by the learner himself. Discovery is good as soon as a minimum fund of information has been learned."[2]

Others, like Bruner, have conceptualized discovery as being a structural model with distinct components. He holds that discovery learning is teaching for a likelihood of transfer, and identifies six problems in this effort. The first problem is what he calls the "attitude problem," by which Bruner means that the student necessarily must believe that he can solve a problem with what he knows or is learning. The second problem is one of "compatibility," which means that the student needs to approach new subject matter in such a way that he is able to fit it into his own system of associations. (This appears to be closely related to the Piagetian notions of assimilation and accommodation.) Unless a student is able to make material compatible, there appears little likelihood that the knowledge will "become his own." Third, there is the problem of getting the child "activated" to the degree that he can begin to explore his own capabilities at problem solving. Fourth, the child needs to be given experience in practicing the "skills" related to using information and problem solving. Bruner calls the fifth problem the "self-loop" problem by which he means getting the child to look back (turn around) on his own behaviors, allowing for reflection, evaluation, and the determination of value of his behaviors. He calls this a separate and special problem of discovery learning, that is, discovering what it is that one has been doing and the productive power of one's actions. The sixth problem is

the capacity of the human organism to "handle information," that is, the problem of channel capacity as information process theorists view it. [3]

As for the technique of inquiry, there are also several definitions, covering the spectrum of concise through quite detailed.

Dr. Theodore Kaltsounis, specialist in social studies education, defined the term in the following manner:

> Inquiry refers to the kind of teaching and learning that is based on involvement and investigation on the part of the child. Inquiry is a process that uses a number of skills - observing, classifying, analyzing, inferring, hypothesizing, reaching conclusions (generalizing), and supporting hypotheses and conclusions. This inquiry, as an approach to teaching and learning, is nothing more than the implementation of the natural way of learning. [4]

A leading spokesman for inquiry, Byron Massialas, and his colleague Jack Zevin felt that inquiry is behavior which is characterized by a careful exploration of alternatives in seeking a solution to a problem. It includes both logical and psychological factors, cognitive and affective behaviors. [5]

Frank Williams, at the 1970 Regional TAG Convention, spoke of inquiry when he said, "It is characterized by giving these children (gifted) a problem and asking them questions to solve it." [6]

Thus, the actual processes of discovery and inquiry move from hunch and intuition to an in-depth analysis and finally to an answer based on evidence.

Many different definitions are in use and one can ask: Why are there so many definitions? Elliot Stern, representative for the Xerox Corporation, said that the reason for so many inquiry approaches is that many experts try to define the learning process in a scientific way - a way which expresses how people learn. Because there is a multitude of ways that individuals learn, so too is there a multitude of definitions for describing these ways. [7]

Are these terms significantly different? After personally consulting one of the most respected experts in the field of the gifted, E. Paul Torrance,

concerning the matter of difference, the authors found him to say, "There is such a fine line between the two terms, that it doesn't seem worth it to make a distinction." [8] Therefore, discovery and inquiry will be dealt with synonymously to reduce confusion, for the purposes of this review.

CHAPTER II

HISTORICAL BACKGROUND

Although the terms discovery and inquiry are relatively new, linguistically speaking, the underlying ideas were practiced all the way back in 300 B.C. with Lao Tse Hung in the northern province of China. Socrates also spoke of these processes when he said, "I shall only ask him, and not teach him, and he shall share the inquiry with me?" [9]

William Bagley, a noted educator, dealt with discovery and inquiry when he wrote:

> The pupil is not to be told but led to see....Whatever the pupil gains, what thought connection he works out, must be gained with the consciousness that he, the pupil, is the active agent, in that he is, in a sense at least, the discoverer. [10]

The progressive education movement, led by John Dewey, had much insight into what is presently called inquiry.

> ...The mind of man is being habituated to a new method and ideal. There is but one sure road of access to truth - the road of patient, cooperative inquiry, operating by means of observation, experiment, record, and controlled reflection. [11]

Dewey had inquiry as a method of learning as being central to all of his writing. He identified learning with thinking, and thinking with the active discovery of relationships and organizing principles. He also felt that problem-solving processes were essential to active learning.

Thus, these approaches have evolved through history. It is evident that the basic underlying concepts were unaltered, but rather the name was changed.

Today there are several educators on "both sides of the fence," in regard to their views toward these techniques.

Several critics have expressed their concern for the use of discovery and inquiry in the classroom. One of these is Friedlander, who felt that there is a greater possibility of failure when these approaches are used. He felt that this failure will dampen the child's interest in learning. He also mentioned that there is a lack of conclusive evidence on the topic. [12] Another critic is Kagan, who said that this approach is good only for the highly motivated child; lower intelligence children need tasks that are immediately rewarding. [13]

Finally, perhaps the most vehement critic of these approaches is Ausubel, who considered discovery approaches a waste of time for the teacher and the student. [14] He also said:

> ...autonomous discovery, as a part of a problem-solving approach to the learning of subject matter, is <u>not</u> considered a prerequisite for the acquisition of meaning (understanding) as long as the learner employs a meaningful set and studies potentially meaningful material. [15]

Other critics generally said that it is pedagogically impractical and argue that it offers little to the learner that cannot be offered equally well by good expository teaching. They also purport that there is very little, if any, positive research for these methods. [16]

On the other hand, there are several who support these approaches as being quite necessary and valuable. Hilda Taba, one of the primary educators in this field, felt that learning by discovery is very beneficial, as since it is an active process, the competency motive as a drive for learning behavior becomes mobilized, the learning act is freed from the immediate stimulus control, and cognitive control of the individual is established. [17]

Atkin and Karplus, other experts in the field, believed that discovery teaching appears to be strongly motivating and rewarding. [18]

Perhaps the leading expert in the area of inquiry today is J. R. Suchman. He has experimented with and taught inquiry as an approach, and has a positive outlook toward its effectiveness:

> The child who is educated in and through the process of inquiry may cover less territory than the child taught through traditional didactics. He may have doubts about the validity of his knowledge and may regard few if any truths as absolute or final. On the other hand, he will be in a better position to know just what it is he does understand, how he came to understand it, and what he can do to pursue it further. Through the power to build and test his own theories and the motivation to raise new questions and open up new problems he will be more likely to continue thinking and learning productively in or out of the school setting, with or without a teacher. [19]

Thus, in summary, the adherents of these approaches basically stated that:

1) They enhance retention and the transfer of concepts.

2) They increase pupil motivation, and

3) They teach the pupils to learn how to discover. [20]

CHAPTER III

IMPLICATIONS FOR THE GIFTED CHILD

According to an old Chinese proverb, "Those who can think learn for themselves and not from the sages." [21] In considering discovery and inquiry as approaches for teaching the gifted, it is necessary to examine the relationship of these approaches to theory and also the rationale for implementing these techniques in the education for academically gifted youngsters.

In order to employ these approaches in the instruction of the gifted child, it is quite important to determine whether or not these techniques are compliable with the child's process of development. Since Piaget is quite respected in the field of developmental theory, it seems justifiable to value his opinion. In his writings, he infers that good pedagogy must involve presenting the child with situations in which he himself experiments, trying things out to see what happens, manipulating things, manipulating symbols, posing questions and seeking his own answers, reconciling what he finds one time with what he finds at another, and finally comparing his findings with those of other children. [22] Hence, since this self-discovery and experimentation is important to growth, and even more so in the gifted youngster, then discovery and inquiry can be considered highly relevant and congruent with the developmental stages of a gifted child.

All definitions of discovery and inquiry contain the essential ingredient of pupil involvement in problem-solving and the development of higher level cognitive skills. [23] Since the gifted child has great potential for higher-level cognitive development, these approaches can be implemented in gifted education at a much earlier stage, and the rate with which these children grasp the essential elements of the approaches will be much faster than that

of a non-gifted child. Interaction with one's environment helps determine the rate and quality of his learning. [24]

The factors of being rather "open" in structure and allowing the students to assume much of the responsibility for the execution of these processes, readily lend themselves to education for the gifted. The teacher's primary goal is to show the student how to learn as he responds to thought-provoking problems. The role of the teacher is to set the stage so that the students become alert and interested in pursuing ideas. Primarily the teacher's work is to open up new vistas, encourage frank questions, and set the stage for explorations of a high order. The student-teacher planning of study projects is a feature of all good schools. Instead of requiring group conformity, the teachers should reward bright students for original thinking. A permissive atmosphere encourages further exploration of problems through the use of many resources. These criteria are quite evident in the discovery and inquiry approaches. Teaching for discovery is a process which can't be tightly scheduled, particularly with bright pupils; the children must be given sufficient opportunity to discover relationships, make comparisons, and draw conclusions so that they perceive and identify the principles involved. [25]

Within the course of these processes, the student discovers facts for himself. This may be more time-consuming than presenting selected facts and requiring the students to learn for themselves. The economy lies in the development of the student's capacity for thinking. Experimental tries are the basis of all effective learning. Through repeated trials the student becomes aware of his successes and failures, overcomes his difficulties, and improves his performance. [26]

The thought processes involve several components. One important factor is curiosity. Inherent to the discovery and inquiry approaches is the idea

of "active" learning on the part of the gifted pupil. The changing of passive orientation calls for a concentrated effort on releasing and promoting curiosity. A school curriculum that stresses uniformity is not conducive to the development of curious learners. [27] Hence, since a high level of curiosity is characteristic of the gifted, a curriculum which de-emphasizes this trait would greatly hinder the learning processes of these children.

Suchman, while his purpose was to develop within children a systematic approach for discovering information on their own, felt that these processes would also raise their level of productive thinking, including critical, evaluative, and divergent. [28]

Creative thinking is also another component of the thought process which is cultivated via the inquiry method, according to Suchman.

> Using creative thinking to promote conceptual growth, while honored by lip service, is not often practiced. One way to do this (via the Inquiry Training Program) is to make the teacher's role less directive and more responsive, to have the learner focus on a problem and allow him to gather data freely with the help but not the direction of the teacher. Rigging the classroom climate and the "payoff matrix" in such a way that children become willing to take risks in trying out new ideas in place of safer but more laborious methods is also useful. [29]

Another component of learning is rational thought, a basis for all education. Wolfe felt that inquiry is necessary to improve the values of rational thought. His seven basic objectives or methods of thought that characterize all of education also concur with the processes of discovery and inquiry:

1) longing to know and understand
2) questioning of all things
3) search for data and their meaning
4) demand for verification
5) respect for logic
6) consideration of premises
7) consideration of consequences [30]

Several other educators have reasons for accepting these techniques as approaches for the education of the gifted. Neff said, "Their (gifted) greater initiative, curiosity, and imagination, and ability to work independently needs an outlet to keep the gifted child interested and productive." [31]

Massialas and Zevin added hope to Neff's concern for the gifted, by giving support to the inquiry approach as a possibility for the gifted child by indicating that:

1) it rescues the child from the deadly boredom of rote learning
2) it expedites memory processing
3) it has a highly motivating effect on gifted students
4) learning becomes active, not passive because the child further sharpens certain human capacities that remained dormant before
5) the child becomes able to develop cognitive functions needed to seek out and organize information in a way that would be the most productive of new concepts
6) the success gives the child increased confidence in his ability to think, strength to be independent, and a minimizing of inner conflicts
7) the student's attitude toward knowledge is changed - after inquiry, knowledge becomes tentative, not absolute
8) the child who is capable of solving social and intellectual problems on his own will be better able and prepared to solve his own emotional problems [32]

Bruner also has his beliefs as to why discovery learning has its distinct advantages. They were:

1) it increases intellectual potency

2) it increases intrinsic motivation

3) it teaches the student the techniques (heuristics) of discovery, and

4) it results in better retention of what is learned [33]

Thus, these approaches have definite significant implications for the gifted child. The approaches seem to support and complement the needs of the gifted in their learning and thought processes. They help them to become independent learners. As Bruner wrote:

> Mastery....involves...also the development of attitude... toward the possibility of solving problems on one's own. To instill such attitude by teaching requires something more than the mere presentation of fundamental ideas... It would seem that an important ingredient is a sense of excitement about discovery. Various people...have urged that it is possible to present the fundamental structure of a discipline in such a way as to preserve some of the exciting sequences that lead a student to discover for himself. [34]

CHAPTER IV

CLASSROOM ADAPTATION

In order to facilitate maximum learning through discovery and inquiry on the part of the gifted pupil, certain characteristics must be present in the classroom itself. The essence of inquiry is freedom, freedom to pursue lines of thought unfettered by textbooks or by the necessity of learning certain facts, concepts, and principles for their own sake. [35]

The atmosphere for inquiry is open and free; the student must feel that what he says is accepted. The teacher must avoid value judgments, but rather should nod or say "okay." [36]

Teaching through inquiry is the process of formulating and testing ideas and implies an open classroom climate that encourages wide student participation and the expression of divergent points of view. A truly inquiry-centered class is a small society whose members utilize the concepts and skills of the arts and the sciences, draw upon their own personal experience, and attempt to deal judiciously with important natural and social problems. In such a class, both teachers and students perform new roles. [37]

A permissive atmosphere cannot be forced into existence and cannot emerge suddenly. Gifted children will accept the atmosphere if it is "natural" to the classroom; by this, it is meant that the child knows that this freedom resulted from the teacher's orientation because of activities that interested both the teacher and the pupil. Teachers who are more traditional and structured in orientation can have this "freedom" in their classrooms too, but by easing it into the atmosphere in small doses.

As for the learning environment, it, of course, also centers in the classroom. Obviously, it should be attractive and orderly, with proper

lighting, ventilation, seating, and appurtenances used in, or conducive to, the teaching-learning act. In evidence should be attractive bulletin boards; points of interest such as science tables and reading corners; listening centers where pupils can use phonographs, radios, and television equipment; individual study areas; and ample books, supplies, and other materials. These physical attributes of the classroom are, however, important only to the extent that they facilitate amenable interpersonal relationships and keep lines of communication open to members of the group, that they help the group develop a sense of responsibility and stimulate achievement motivation. 38

There are also some other important characteristics of this discovery-inquiry based classroom and they are listed below:

1) Questions and problems which are studied can be the result of chance occurrence or originate within the class itself.
2) Procedures originate in pupil-teacher discussion; then questions and problems are cooperatively analyzed.
3) The gifted child often proposes hypotheses which can lead to experimentation, observation, and analysis.
4) The gifted child uses texts and trade books as sources of information, not as the final authoritative answer.
5) The data gathered from the various sources are cooperatively evaluated in order to assess a hypothesis.
6) The gifted evaluate their success (or lack of it) in solving the problem with which they were concerned.

7) Time is set aside for important activities; there is no compulsion to "finish the textbook." [39]

Besides having certain characteristics necessary for the classroom, there are also certain tools and materials that will facilitate the usage of the approaches in instructing the gifted. To expedite matters, some suggested materials are listed below with a comment on their efficiency:

1) Guest speakers - can present important ideas and questions in a provocative manner that would facilitate discussion
2) Films - bring to child experiments and many demonstrations that are impractical to perform in class; they also pose questions for discussions. It is best not to show films just for the sake of "showing," but rather for a definite purpose
3) Television - since it is very structured sometimes, it is good for a beginning "take-off" lesson; it presents experiences of the whole world (i.e. moon landing, rocket launch, etc.)
4) Filmstrips and slides - good for things that can't be handled concretely in class; since there is no narration, a stimulating discussion can be held simultaneously
5) Chalkboard - effective, but only if the child can use it, too
6) Transparencies - child can see the teacher and the writing at the same time; good for seeing relationships

7) Flannel board - good to have handy in every room for a display that might last for an extended length of time

8) Bulletin board - effective if it generates or focuses interest on new phases; often an excellent starting point for inquiry

9) Records and tapes - records are not really very effective at the present time; tapes, however, are quite beneficial if the child does his own recording

10) Opaque projector - effective if there are enough pictures to show; easy and efficient way to show a diagram

11) Models - facilitate examining parts and their relationships; effective for posing problems and questions

12) Diorama - effective way to display a certain concept or idea

As can be readily observed from the characteristics of a classroom and materials of this nature, the learning is pupil-oriented, whereas the teacher plays an important role in guaranteeing the success of the approaches. Crucial to these approaches is the fact that more time for planning must be spent by the teacher, since he/she must be quite knowledgeable for suggesting resources, helping discussion, and in questioning.

Massialas defined the teacher as having six different functions in his/her role as an adherent of the discovery-inquiry approaches:

1) Teacher as a <u>planner</u>:

The teacher plans the learning activities and collects and prepares materials.

2) Teacher as an introducer:

The teacher seizes the "teachable moment;" he/she stimulates the "discovery episode" which is designed to create a problematic, provocative situation in which the students are prompted to develop concepts and relationships for themselves. Sometimes students introduce inquiry situations from their own experiences.

3) Teacher as a questioner: as a sustainer of inquiry:

The attitude of the teacher must be that he/she has no final or absolute answer to give out. All claims and statements are to be examined and then accepted or rejected in the open forum of ideas. The teacher encourages exploration of different alternatives to problems through questioning. He/she often plays the role of "devil's advocate" by throwing the questions back at the students.

4) Teacher as a manager:

The teacher still retains such managerial routines as: recognizing students, maintaining records and reasonable order, and handling of announcements.

5) Teacher as rewarder:

The teacher also suggests, praises, and encourages the students, but never criticizes, commands, or punishes them.

6) Teacher as a value investigator:

With questions of value, the teacher places emphasis on the processes of discovery and inquiry and on the

idea that value judgment must be publicly defensible. Usually the teacher refrains from taking a definite position in indroductory phases of the discussion. However, he/she may decide to express an opinion later. [40]

In a joint project with Massialas, Sugrue and Sweeney devised a checklist entitled, "Am I an Inquiry Teacher?"; it directly relates to the six functions of the teacher. Each question can be answered from four alternatives: regularly, frequently, sometimes, and seldom.

"Am I an Inquiry Teacher?"

1) As Planner
   A. I focus on lessons involving exploration of significant ideas, concepts, or problem areas that can be investigated at many levels of sophistication.
   B. I prepare for a broad range of alternative ideas and values which the students may raise related to a central topic.
   C. I select materials and learning experiences to stimulate student curiosity and support student investigation.
   D. I make available a wide variety of resources and material for student use.
   E. Skill-building exercises are tied directly to on-going learnings where they can be utilized and applied.

2) As Introducer
   A. My introductory lessons present some problem, question, contradiction, or unknown element that will maximize student thinking.
   B. My aim is for students to react freely to the introductory stimulus with little direction from me.
   C. I encourage many different responses to a given introductory stimulus and am prepared to deal with alternative patterns of exploration.

3) As Questioner and Inquiry Sustainer
   A. The students talk more than I do.
   B. Students are free to discuss and interchange their ideas.
   C. When I talk, I "question," not "tell."
   D. I consciously use the ideas students have raised and base my statements and questions on their ideas.

E. I redirect student questions in such a way that students are encouraged to arrive at their own answers.
F. My questions are intended to lead the pupils to explore, explain, support, and evaluate their ideas.
G. I encourage the students to evaluate the adequacy of grounds provided for statements made by them or by others.
H. Students gain understanding and practice in logical and scientific processes of acquiring, validating, and using knowledge.
I. My questions lead the students to test the validity of their ideas in a broad context of experience.
J. I encourage students to move from examination of particular cases to more generalized concepts and understandings.

4) As Manager
A. I emphasize learning and the use of ideas, rather than managerial functions, such as discipline and record keeping.
B. I allow for flexible seating, student movement, and maximum student use of materials and resources.
C. Class dialogue is conducted in an orderly fashion that emphasizes courtesy and willingness to listen to each person's ideas.
D. Students are actively involved in the planning and maintenance of the total classroom environment.
E. I foster balanced participation by encouraging the more reticent students to take an active role in classroom activities.

5) As Rewarder
A. I encourage and reward the free exchange and testing of ideas.
B. I emphasize the internal rewards that spring from the successful pursuit of one's own ideas.
C. I avoid criticizing or judging ideas offered by students.
D. Each student's contribution is considered legitimate and important.
E. I evaluate students on growth in many aspects of the learning experience, rather than simply on the basis of facts acquired.

6) As Value Investigator
   A. I emphasize that concepts, social issues, policy decisions, attitudes, and values are legitimate areas for discussion.
   B. All topics are critically examined, not "taught" as closed issues with a single "right" solution.
   C. Use of unfounded, emotionally charged language is minimized in discussing attitudes and values.
   D. I encourage all students to explore the implications of holding alternative value and policy positions.
   E. I make the students aware of personal and social bases for diversity in attitudes, values, and policies.
   F. I encourage the students to arrive at value and policy positions of their own that they understand and can defend. [41]

The variety of roles for the teacher lends itself to several implications for the teacher in these processes. The methods of instruction should lead the pupil to discover for himself important relationships and processes. Experimental work and first-hand investigation have priority in the student's modes of learning. Thus, this experimentation and investigation involves the production of new ideas: movement from the known to the unknown. Teachers want to move ahead from a sole preoccupation with the transmission of subject matter to the development of knowledge. They are not satisfied with being technicians only, but they wish to experience the rewards of creating and developing this ability in children. This movement from the known to the unknown is characterized by a phase of disorder. (The teacher must be willing to give up a little of his/her reins on teaching and give the children more freedom.) The learner starts with the known, and then experiences a phase of disorder where he moves in divergent directions; he reacts to the stimulus in his own individualistic way; not being clear about the direction, he tries different ideas. He may pass an incubation period. Finally, the learner reaches his own insight and orders a new knowledge. The teacher who settles for the security of the known and because of

the threats of the unknown is deterring both his professional and personal growth. [42]

Another important implication for teachers involves the use of questioning. Emphasis must be refocused on finding answers rather than on the answers themselves. Thus, the heart of teaching and learning by the discovery-inquiry approach is in questions properly asked and answers to them properly used. Surveys done by Carin indicated that over 90 per cent of all questions teachers ask call merely for reproducing what was just read, heard, or seen by the children. Not only do teachers ask too many questions, but they also ask the wrong kinds of questions. [43] Carin suggested twelve ways for teachers to improve their questioning skills for the discovery-inquiry approaches:

1) Write down the specific wording of 6-8 questions in the lesson plan before coming to class.
2) Ask the questions as simply, concisely, and directly as possible.
3) Ask the questions before designating which child should answer.
4) Ask an individual child to respond to a question.
5) Ask questions of as many children as possible during the lesson.
6) Ask a question about the most obvious part of the investigation for the first question.
7) Ask as many questions that stimulate the creative thinking process as possible from these categories:
   a. comparison
   b. summarization
   c. observation
   d. classification
   e. interpretation
   f. criticism
   g. making assumptions
   h. collection and organization of data
   i. evaluation
8) Ask questions that give a child practical experience.
9) Ask questions that lead to actual experimentation.
10) Ask questions in a variety of ways.
11) Avoid asking questions that inhibit investigation.
12) Avoid repeating the children's answers. [44]

Another important aspect of the teacher's role is motivation. One of the basic strengths of these approaches lies in the fact that the motivation is shifted from the teacher to the pupil. However, the teacher must still assume some responsibility for motivating the pupils. Perhaps one of the most crucial duties of the teacher in the motivation realm is helping the gifted child to become aware of the processes he used in his thinking. This, in itself, becomes an intrinsic form of motivation for the child. Another important influence on motivation is the student's own appraisal of his ability to achieve goals that he considers worthwhile. [45] Bruner said that the autonomy of self-reward maximizes the conditions for inquiry, and that the teacher should encourage the student to develop an image of self-capability and of individual accomplishment. [46] This is particularly relevant for the gifted where self-concept and intrinsic reward are so important.

Thus, as a result of these processes, the gifted understand relationships and acquire new concepts. They learn to arrive at sound decisions through their own reasoning powers and to solve problems with imagination and origination. In problem solving, the gifted learn the bases of evidence, the nature of objectivity in thought, the sources of fallacies met in reading. They (gifted) learn the scientific method of thinking as they find that statements must be substantiated with evidence. These same children now develop the habit of asking: How do you know that? What are the facts? Where did you get your evidence? [47] Thus, as a result, the reward becomes internalized and the motivation intrinsic.

CHAPTER V

CURRICULUM ADAPTATION

Before actually dealing with the current programs that use discovery and inquiry in their curriculum, the most recent research concerning these two methods will be reviewed.

Of particular significance to the gifted is a study concerning a course on inquiry training of Pielstick with gifted children as part of the deKalb, Illinois experiment. The development of divergent thinking and creativity was also attempted. He concluded that "The most profitable course for research is the creation of ways to structure learning situations which will permit the excitement of discovery and disencumber thinking." [48]

Science lends itself easily to these approaches, as their format closely resembles the scientific method. Related to this was Renner, who after much research at the Science Educational Center at the University of Oklahoma, found that specialized educational experiences in inquiry-centered science teaching encourages a teacher to become sensitive to children, functionally aware of purposes of education, and equipped to lead children to learn how to learn in all subject areas. [49]

In the area of mathematics, there have also been some studies, one of which was performed by Worthen. He found that sixth grade pupils taught by the discovery method were able to retain significantly more material over an intervening period than the group taught by the expository method. He further suggested that the presentation of mathematical concepts to sixth grade pupils through discovery sequencing causes the learner to integrate the content conceptually in such a manner that he can retain it more readily than if concepts had been taught in an expository manner. He concluded that learning by techniques of discovery significantly increase the pupil's ability

to use discovery problem solving approaches in new situations, both those which require paper-and-pencil application, and those which involve verbal presentation by the teacher. The results of this study indicated that the discovery method need not be more time consuming than the expository method for this grade level. [50]

In a general summary of recent research on discovery, Craig noted two hypotheses that were consistently supported:

1) Guided discovery, that is, stating or showing the content, principles, or methods which are to be learned, gives better results if the objectives are learning retention, and the application of what is learned.

2) Discovery techniques, that is, allowing the student to discover what is to be learned, are more effective if the objective is the inference and use of new principles and methods. [51]

On the college level, there was an experimental study performed by Good, et al., that showed that students who followed the experimental program (discovery-inquiry) developed inquiry skills to a significantly greater degree than students in the control group. [52]

Perhaps the most recent experiment performed in this area was one done by Sprague, Sweeney, and Massialas in 1970. Their purpose was to determine effective teaching strategies and practices in classroom discussions of social issues. There were several significant results relevant to this review:

1) Teachers in inquiry classes asked more open-ended, nonexpository questions than teachers in expository classes.

2) The students in the inquiry classes performed better on the social issues critical thinking test than the students in the expository classes. 53

As for implementing these approaches in a curriculum for gifted children, it becomes imperative to be familiar with specific activities and techniques that foster the discovery-inquiry approach. The following may be found in new projects and curricula:

1) analyzing source materials
2) doing field studies
3) examining artifacts
4) using autobiographies and diaries
5) interviewing specialists
6) making case studies
7) observing political or other activities
8) taking polls on issues
9) using questionnaires
10) keeping logs and diaries
11) analyzing models
12) simulating decision-making processes
13) role playing
14) interpreting maps and photographs
15) interpreting models made by others
16) making and analyzing recordings
17) making maps, charts, graphs
18) making models

Within the curriculum there are certain specific programs that implement the discovery-inquiry approach in their methodology. Some are:

A. Mathematics

1) SMSG (School Mathematics Study Group) - emphasizes that the concepts of mathematics are part of a whole, and not merely one subdivision

2) Greater Cleveland Mathematics Project - "guided discovery" is the essential ingredient of this curriculum, which is based on the spiraling sequence

3) University of Illinois Committee on School Mathematics - leads students to discover principles for themselves; it emphasizes "learning by discovery" with the students working out mathematics rather than being told about it

B. Physical and Biological Sciences

1) BSCS (Biological Sciences Curriculum Study) - students should be involved in discovery instead of cut-and-dried laboratory experiments

2) CHEM Study (Chemical Educational Material Study) - relies on experimentation in the laboratory; principles are developed through a student's lab discoveries

3) PSSC (Physical Science Study Committee) - laboratory experiences provide first-hand discovering and verifying physical phenomena

4) SCIS (Science Curriculum Improvement Study) - a science study for the primary grades which encourages children to think for themselves

5) ESS (Elementary Science Study) - purpose is to cultivate the child's capacity for inquiry

C. Social Sciences

1) Social Studies Program in Research - program in universities that employs the teaching technique of the inquiry approach

2) Social Studies Curriculum Program - uses the discovery method and employs a broad range of instructional materials

3) Elkhart Experiment in Economic Education - based on the assumption that children can grasp an abstract idea if it forms a part of their own experiences

4) Bridges to Inquiry - a social science program produced by Xerox. It provides learning situations that help students to sharpen skills in handling information, test out facts and beliefs, compare and combine personal thoughts with those of others, and learn new skills in thinking for one's self. The actual inquiry process is in three steps: open-ended question asked by the teacher, group responses, and value analysis. [54]

D. Humanities

1) The English Program - taught inductively and emphasizes depth and analysis

E. Health Education

1) School Health Education Study - emphasizes decision-making and interaction

Another inquiry program, which is only for gifted youngsters, is the Talcott Mountain Science Center in Avon, Connecticut. Here, children working in the natural sciences, learn the techniques of field work and laboratory study. [55]

There are also schools around the United States that are quite dedicated to the discovery-inquiry approaches. In the field of mathematics there is a program called the Madison Project of Syracuse University and Webster College. It has as its primary objective to give the child an experience in discovering mathematical patterns in abstract situations. The Miquon School in Miquon, Pennsylvania, has experiences of discovery in their setting. As one teacher there put it, "Discovery makes excitement contagious." [56] Other schools worth acknowledging are Cabot School in Newtonville, Massachusetts, which uses discovery in their individualized reading program, and Bronx High School of Science, which employs inquiry in their laboratory experiences. [57]

Many programs concerning the discovery-inquiry approach have also been devised with the intent of training the teachers. In Missouri, for example, there was recently a 32-week in-service training program for teachers. The purpose of this training was to give the teachers ideas for improving their inquiry instruction. [58]

Finally, it would seem justifiable to mention the Inquiry Training Program of J. R. Suchman at the University of Illinois. His major interest was in teaching youngsters what he calls "methods of inquiry." In the process of his investigations he has found that, for example, in a typical elementary classroom, a teacher will ask from 8 to 10 times as many questions as the children. This would seem to be a very strange state of affairs when one considers the excited curiosity and interest typical of the young child. Suchman suggested that the pupils have been trained out of inquiry and wait passively to receive the knowledge presented to them. He used films as a stimulus. In these films the children are given an experience which, from their standpoint, is unexplainable. For instance, a demonstration involving use of a heated brass ball and a brass ring has resulted in the following dialogue:

Pupil : Were the ball and ring at room temperature to begin with.
Teacher: Yes.
Pupil : And the ball would go through the ring at first?
Teacher: Yes.
Pupil : After the ball was held over the fire it did not go through the ring. Right?
Teacher: Yes.
Pupil : If the ring had been heated instead of the ball, would the results have been the same?
Teacher: No.
Pupil : If both had been heated, would the ball have gone through then?
Teacher: That all depends.
Pupil : If they had both been heated to the same temperature, would the ball have gone through?
Teacher: Yes.
Pupil : Would the ball be the same size after it was heated as it was before?
Teacher: No.
Pupil : Could the same experiment have been done if the ball and ring were made out of some other metal?
Teacher: Yes.

The children are taught to use a three-stage plan in developing logical, systematic approaches. First, they are asked to identify, verify, and measure the parameters of a given problem. In this process, they identify objects, observe the properties of these objects, note the conditions or states of the objects, and discover changes in the conditions. Second, they determine the relevance of particular conditions in producing the events of a scientific episode, for all conditions are not relevant. Third, they formulate and test theoretical constructs that show relationships among the variables of the observed physical event. This action calls for flexibility and imagination in asking questions.

Training sessions of an hour or less are held at intervals of several days. A silent motion picture of a physics demonstration is shown. This picture raises questions about cause and effect, and the children begin immediately to ask probing questions which are to be answered "yes" or "no." "Yes" and "no" questions test hypotheses; therefore, the teacher who answers them is helping them to establish the tenability or untenability of their hypotheses.

During the first stage, the children ask questions of verification. During stages two and three, they ask questions of an experimental nature, stating a set of conditions and postulating a result. Here, the teacher's answer tells whether the postulated result will or will not occur. If the teacher cannot give an unequivocal answer, he says, "That all depends," or "Tell me more," indicating that the child's "experiment" has not been sufficiently controlled. When the children try to tap the teacher's understanding, the teacher's response may be, "What could you do to find out for yourself?"

After the period of inquiry through questioning, a critical review of the process is conducted by teacher, pupils, and any observers who may be present. From this review, the children are expected to learn improved strategies of inquiry. The children apparently have little interest in improving their inquiry skills per se, but they are willing to improve them in the context of understanding cause-and-effect relationships. The children used in the experiments have often been at the sixth grade level. [59]

Thus, these approaches have been implemented in all aspects of the curriculum.

CHAPTER VI

CONCLUSION

In concluding, it becomes necessary for the authors to offer a few suggestions that might improve the discovery and inquiry approaches in their implementation as well as in their present state in the educational realm. First of all, it is important that the teacher not consider these approaches exclusively for the gifted in the classroom situation. As Martinson wrote, "Gifted children do not need to employ techniques of discovery or inquiry or problem-solving in every enterprise." [60] Torrance went further along this same line to say, "The creative way of learning must not be regarded as the exclusive way of learning for all children." [61] Often the material and general mood of the class warrants a more didactic approach to teaching and learning. It is best for the teacher to be flexible and not rely solely on either approach, but rather use both techniques at their appropriate time. Another important criterion to consider is when to implement these approaches in the classroom setting. In order for gifted children to benefit the most, these approaches should be initiated as early as possible in the child's educational experiences. Then by the time the gifted children reach the secondary level, they are aware of their thought processes and will have mastered some of the basic concepts of experimentation and analysis.

Many of the critics of these approaches claim that there is not substantial evidence that supports these techniques as being successful. Therefore, it is crucial to the future of these approaches to obtain more experimental research that validates the positive effects of their successful results when applied to a gifted classroom situation.

Finally, it is important to emphasize how beneficial these approaches can be for the gifted child. For the gifted, the most important result of

learning through discovery and inquiry is a change of attitude toward knowledge. They begin to view knowledge as being tentative rather than absolute, and they consider all knowledge claims as being subject to continuous revision and confirmation. [62] The gifted child is often creative and has highly developed thought processes which should be stimulated and challenged. Through discovery and inquiry, the gifted child is helped to become a productive inquirer and a more independent learner who can shape the learning situation to match his own individual cognitive style and goals. One of the goals in teaching the gifted is to stimulate an attitude or approach toward the world, as much as to provide an infusion of knowledge of specific content. By using discovery and inquiry, the gifted derive increased faith in the regularity of the universe. They come to have a greater sense of autonomy and self-esteem which, in turn, leads to further discovery and inquiry and other forms of productive thinking. These children must be challenged to retrieve them from the boredom that they so often experience. "Gifted children should be asked more than to be walking memory banks - they must also be problem solvers and creative thinkers." [63] There are many problems for them to solve - right now. As President Richard M. Nixon said in his 1970 State of the Union Address:

> The great question of the 70's is shall we surrender to our surroundings or shall we make our peace with nature and begin to make reparations for the damage we have done to our air, our land, and our water. [64]

FOOTNOTES

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[2]Arthur J. Ter Keurst and Joanna Martin, "Rote vs. Discovery Learning," School and Community, 65:42, November, 1968, p. 42.

[3]Jerome S. Bruner, The Process of Education (Cambridge: Harvard University Press, 1962), pp. 103-113.

[4]Theodore Kaltsounis, "What About Inquiry?", Instructor, 80:49-51, April, 1971, p. 50.

[5]Byron G. Massialas and Jack Zevin, Creative Encounters in the Classroom: Teaching and Learning Through Discovery (New York: John Wiley & Sons, Inc., 1967), p. 19.

[6]Opinion expressed by Frank E. Williams in an address "Practical Implementation of Theoretical Implications for the Gifted and Talented," at Northeast Regional Conference for the Association for the Gifted (New Haven, Connecticut), November 6, 1970.

[7]Opinion expressed by Elliot Stern in a workshop "Inquiry Teaching and the Educational Process" at the University of Maryland, College of Education (College Park, Maryland), April 28, 1971.

[8]Statement by E. Paul Torrance, personal interview, November 5, 1970.

[9]Plato, Meno (Indianapolis: Bobbs-Merrill Company, Inc., 1949), p. 39.

[10]William C. Bagley, The Educative Process (New York: Macmillan Company, 1905), p. 262.

[11]John Dewey, "Faith and Its Object," Basic Problems of Philosophy (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 497.

[12]Joe L. Frost and G. Thomas Rowland, Curricula for the Seventies (Boston: Houghton Mifflin Company, 1969), p. 161.

[13]Ibid., p. 162.

[14]Ibid., p. 161.

[15]Ibid., p. 163.

[16]Blaine R. Worthen, "A Study of Discovery and Expository Presentation: Implications for Teaching," The Journal of Teacher Education, 19:223-242, Summer, 1968, p. 225.

[17]Hilda Taba, "Learning by Discovery: Psychological and Educational Rationale," Elementary School Journal, 63:308-316, 1963, p. 312.

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[19]J. R. Suchman, "Inquiry and Education," Intellectual Development: Another Look, December, 1962.

[20]Worthen, op. cit., p. 223.

[21]Gertrude H. Hildreth, Introduction to the Gifted (New York: McGraw-Hill Book Company, 1966), p. 224.

[22]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach (Belmont, California: Wadsworth Publishing Co., 1968), p. 98.

[23]William K. Esler, "Structuring Inquiry for Classroom Use," School Science and Mathematics, 70:454-458, May, 1970, p. 454.

[24]Cole S. Brembeck, The Discovery of Teaching (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1962), p. 113.

[25]Ruth A. Martinson, Curriculum Enrichment for the Gifted in the Primary Grades (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1968), p. 22.

[26]Hildreth, op. cit., p. 223.

[27]Abraham Shumsky, In Search of Teaching Style (New York: Appleton-Century-Crofts, 1965), p. 231.

[28]J. R. Suchman, "Creative Growth and Conceptual Growth," Gifted Child Quarterly, 6:93-94, Autumn, 1962, p. 93.

[29]J. R. Suchman, "Creative Growth and Conceptual Growth," Gifted Child Quarterly, 6:95-99, Autumn, 1962, p. 95.

[30]Dael Wolfe, "The Spirit of Science," Contemporary Thought on Public School Curriculum: Readings, eds. Edmund C. Short and George D. Marconnit (Dubuque, Iowa: William C. Brown Company Publishers, 1968), p. 126.

[31]Herbert B. Neff, "Ways to Help Gifted Students Like Social Studies," Gifted Child Quarterly, 11:108-11, Summer, 1967, p. 108.

[32]Massialas and Zevin, op. cit., p. 266.

[33]Frost and Rowland, op. cit., p. 161.

[34]Bruner, op. cit., p. 20.

[35]Kuslan and Stone, op. cit., p. 145.

[36]Stern, op. cit.

[37]Byron G. Massialas, "Inquiry," Today's Education, 58:40-42, May, 1969, p. 42.

[38]James C. Stone and Frederick W. Schneider, Foundations of Education (New York: Thomas Y. Crowell Company, 1965), pp. 134-135.

[39]Kuslan and Stone, op. cit., p. 145.

[40]Massialas, op. cit., pp. 41-42.

[41]Mary Sugrue and Jo Ann Sweeney, "Inquiry-Teaching Technique," Today's Education, 58:43-44, May, 1969, p. 44.

[42]Shumsky, op. cit., pp. 54-57.

[43]Arthur A. Carin, "Techniques for Developing Discovery Questioning Skills," Science and Children, 7:13-15, April, 1970, p. 13.

[44]Carin, op. cit., pp. 14-15.

[45]Massialas and Zevin, op. cit., p. 22.

[46]Frost and Rowland, op. cit., p. 161.

[47]Hildreth, op. cit., p. 225.

[48]N. L. Pielstick, "Gifted Children and Learning Experiences," Journal of Educational Research, 57:125-130, November, 1963, p. 29.

[49]John W. Renner and Donald G. Stafford, "Inquiry, Children, and Teachers," The Science Teacher, 37:55-57, April, 1970, pp. 55-57.

[50]Worthen, op. cit., pp. 240-242.

[51]Robert C. Craig, "Recent Research on Discovery," Educational Leadership, 26:501-505, February, 1969, pp. 504-505.

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[54]Stern, op. cit.

[55]Donald P. LaSalle and George C. Atamian, "Student Involvement: Bridging the Education Gap," September, 1970, p. 2.

[56]Benjamin Fine, Stretching Their Minds (New York: E. P. Dutton & Co., Ind., 1964), p. 52.

[57]Ibid., p. 60.

[58]B. Charles Leonard and Frederick John Gies, "I[3]: Improving Instruction Through Inquiry," School and Community, 56:8-9, February, 1970, pp. 8-9.

[59]Stone and Schneider, op. cit., pp. 130-131.

[60]Martinson, op. cit., p. 22.

[61]E. Paul Torrance, Encouraging Creativity in the Classroom (Dubuque, Iowa: William C. Brown Company Publishers, 1970), p. 13.

[62]Massialas, op. cit., p. 42.

[63]James J. Gallagher, Teaching the Gifted Child (Boston: Allyn and Bacon, Inc., 1964), p. 210.

[64]Kenneth Cummings, "Discovery Learning with Illustrations," The High School Journal, 53:281-297, February, 1970, p. 297.

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